

WHAT IS CLAIMED IS:

1.      Gastrointestinal-tract apparatus comprising:  
  
a sensor adapted to move along and measure a length of a gastrointestinal tract from a reference point to a site of interest in the gastrointestinal tract.
2.      Apparatus according to claim 1 wherein said sensor comprises a physiological detector adapted to output physiological information about a characteristic physiological feature of tissue in the gastrointestinal tract.
3.      Apparatus according to claim 1 and comprising an ingestible pill, wherein said sensor is substantially internal to said pill.
4.      Apparatus according to claim 1 and comprising a position detector adapted to output positional information about a position of said sensor in the gastrointestinal tract.

5. Apparatus according to claim 4 wherein said position detector is internal to said sensor and is adapted to transmit the positional information to a position tracking system.

6. Apparatus according to claim 4 wherein said position detector is external to said sensor and is adapted to track the position of said sensor in the gastrointestinal tract, and transmit the positional information to a position tracking system.

7. Apparatus according to claim 4 wherein said sensor comprises a memory device adapted to record data from said position detector.

8. Apparatus according to claim 7 and comprising a reader adapted to read data stored in said memory device.

9. Apparatus according to claim 4 wherein said sensor comprises a physiological detector adapted to output physiological information about a characteristic physiological feature of tissue in the gastrointestinal tract.

10. Apparatus according to claim 9 wherein said sensor comprises a memory device adapted to record data from said physiological detector.

11. Apparatus according to claim 10 and comprising a reader adapted to read data stored in said memory device.

12. Apparatus according to claim 9 and comprising a processor adapted to correlate the position of said sensor with the characteristic physiological feature of the tissue detected by said sensor at the position of said sensor.

13. Apparatus according to claim 9 wherein said physiological detector comprises a radiation detector adapted to output the physiological information responsive to a level of radiation generated by a radiopharmaceutical.

14. Apparatus according to claim 13 wherein said radiation detector comprises a gamma radiation sensor.

15. Apparatus according to claim 13 wherein said radiation detector comprises a beta radiation sensor.

16. Apparatus according to claim 13 wherein said physiological detector comprises a plurality of radiation detectors placed at different positions in said sensor.

17. Apparatus according to claim 16 and comprising a processor in communication with said sensor, wherein said processor is adapted to calculate a distance traveled by said sensor as a function of radiation counts per unit time generated by said plurality of detectors.

18. Apparatus according to claim 9 wherein said physiological detector comprises a plurality of ultrasound sensors placed at different positions in said sensor.

19. Apparatus according to claim 18 and comprising a processor in communication with said sensor, wherein said processor is adapted to calculate a distance traveled by said sensor as a function of an amplitude of an ultrasonic pulse echoing off an internal wall of the gastrointestinal tract.

20. Apparatus according to claim 9 wherein said physiological detector comprises a plurality of light sensors placed at different positions in said sensor.

21. Apparatus according to claim 20 and comprising a processor in communication with said sensor, wherein said processor is adapted to calculate a distance traveled by said sensor as a function of an amplitude of a light pulse reflecting off an internal wall of the gastrointestinal tract

22. Apparatus according to claim 9 wherein said physiological detector comprises a plurality of physiological detectors placed at different positions in said sensor, wherein the apparatus comprises a processor in communication with said sensor, and wherein said processor is adapted to

calculate a distance traveled by said sensor responsive to signals generated by said plurality of physiological detectors.

23. Apparatus according to claim 1 and comprising a power source adapted to power said sensor, wherein said power source is adapted to move along with said sensor.

24. Apparatus according to claim 1 and comprising an external magnetic navigation system adapted to track a position of said sensor through the gastrointestinal tract.

25. Apparatus according to claim 24 wherein said external magnetic navigation system is adapted to sense the position of said sensor at a first position and at a second position in a coordinate system, and calculate the distance between the first and second positions.

26. Apparatus according to claim 24 wherein said external magnetic navigation system is adapted to sense the position of said sensor at predetermined time intervals.

27. Apparatus according to claim 1 wherein said sensor comprises a plurality of rotatable, at least partially round elements disposed on an outer surface of the sensor.

28. Apparatus according to claim 27 and comprising a processor in communication with said sensor, wherein said processor calculates a distance traveled by said sensor as a function of rotation of said at least partially round elements.

29. Apparatus according to claim 28 wherein said processor is in optical communication with said sensor.

30. Apparatus according to claim 28 wherein said processor is in magnetic communication with said sensor.

31. Apparatus according to claim 4 wherein said position detector comprises an inertial sensor that senses accelerations of said sensor in at least three degrees of freedom.

32. Apparatus according to claim 31 and comprising a processor adapted to correlate the position of said sensor with the accelerations sensed by said inertial sensor.

33. Apparatus according to claim 32 and comprising an external accelerometer adapted to be worn by a patient and to sense accelerations of the patient's body.

34. Apparatus according to claim 33 wherein said processor is adapted to take into account differences between accelerations sensed by said inertial sensor and accelerations sensed by said external accelerometer.



35. A method for sensing in a gastrointestinal tract, the method comprising:

sensing a length traveled by a sensor in a gastrointestinal tract from a reference point to a site of interest in the gastrointestinal tract.

36. The method according to claim 35 wherein sensing the length comprises sensing the length traveled by a sensor included in an ingestible pill.

37. The method according to claim 35 and comprising sensing positional information about a position of said sensor in the gastrointestinal tract.

38. The method according to claim 37 and comprising sensing a characteristic physiological feature of tissue in the gastrointestinal tract.

39. The method according to claim 38 and comprising correlating the position of said sensor with the characteristic physiological feature of the tissue.

40. The method according to claim 38 wherein sensing said characteristic physiological feature comprises sensing a radiation level due to a radiopharmaceutical.

41. The method according to claim 35 wherein sensing the length comprises calculating a distance traveled by said sensor as a function of radiation counts per unit time generated by a plurality of radiation detectors coupled to said sensor.

42      The method according to claim 35 wherein sensing the length comprises:

detecting, with a plurality of ultrasound sensors coupled to the sensor,  
an ultrasonic pulse echoing off an internal wall of the gastrointestinal tract;  
and

calculating a distance traveled by said sensor as a function of an amplitude of the ultrasonic pulse.

43 The method according to claim 35 wherein sensing the length comprises:

detecting, with a plurality of light sensors coupled to the sensor, a light pulse reflecting off an internal wall of the gastrointestinal tract; and

calculating a distance traveled by said sensor as a function of an amplitude of the light pulse.

44. The method according to claim 35 wherein sensing the length comprises:

detecting accelerations of said sensor as said sensor moves in the gastrointestinal tract; and

calculating a distance traveled by said sensor as a function of said accelerations.

45. The method according to claim 44 wherein the gastrointestinal tract is in a patient's body, and the method further comprises detecting accelerations of the patient's body, wherein said calculating does take not into account any acceleration that is common to both said inertial sensor and the patient's body.

46. The method according to claim 35 and comprising recording in said sensor positional information about a position of said sensor in the gastrointestinal tract.

47. The method according to claim 46 and comprising reading said positional information after said sensor passes from the gastrointestinal tract.

48. The method according to claim 35 and comprising recording in said sensor information about a characteristic physiological feature of tissue in the gastrointestinal tract.

49. The method according to claim 48 and comprising reading said information about a characteristic physiological feature of tissue, after said sensor passes from the gastrointestinal tract.

50. An ingestible pill, comprising:  
a radiation detector adapted to measure, at a plurality of sites of a gastrointestinal tract, radiation generated by a radiopharmaceutical.

51. The pill according to claim 50, wherein said radiation detector comprises a gamma radiation sensor.

52. The pill according to claim 50 wherein said radiation detector comprises a beta radiation sensor.

53. The pill according to claim 50 and comprising a position detector, adapted to output positional information about a position of said pill in the gastrointestinal tract.

54. The pill according to claim 53, wherein said position detector comprises at least one ultrasound detector, fixed to the pill.

55. The pill according to claim 53, wherein said position detector comprises at least one light detector, fixed to the pill.

56. The pill according to claim 53, wherein said position detector comprises a plurality of radiation detectors, disposed at respective sites of the pill.

57. The pill according to claim 50, wherein said radiation detector is adapted to measure radiation generated by a radiopharmaceutical administered to the gastrointestinal tract.

58. The pill according to claim 50, wherein said radiation detector is adapted to measure radiation generated by a radiopharmaceutical administered to a site external to the gastrointestinal tract.

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59. The pill according to claim 58, wherein said radiation detector is adapted to measure radiation generated by a radiopharmaceutical administered intravenously.

60. A method for measuring radiation, comprising:

administering an ingestible pill including a radiation detector adapted to measure, at a plurality of sites of a gastrointestinal tract, radiation generated by a radiopharmaceutical.